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CP/M Plus™
(CP/M® Version 3)

TRS-80® Model 4
Reference Manual

CP/M Plus™
(CP/M®Version 3)

TRS-80®Model 4

Reference Manual

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Foreword

This Reference Manual describes the CP/M Plus™ user and programmer interfaces as they have been customized on the Radio Shack® TRS-80® Model 4 microcomputer. The discussion assumes that you are familiar with the physical and operational characteristics of the TRS-80 Model 4 microcomputer as described in the Radio Shack delivered documentation.

For a complete discussion of the features, facilities and characteristics of the basic CP/M Plus operating system you should refer to "CP/M Plus (CP/M Version 3) Operating System User's Guide" by Digital Research. This guide provides an in-depth discussion of CP/M Plus, its commands, its utilities and its file system. In particular you should read The Introduction chapter which covers Starting CP/M®3, The Command Line, backing up diskettes and making copies of your diskettes. This TRS-80 Reference Manual describes the features, facilities, characteristics and utilities that are unique to this customization of CP/M Plus.

Section 1 presents the TRS-80 Model 4 features and facilities that the customized CP/M Plus supports. Section 2 describes the SETUP utility program that allows you to configure the desired system. Section 3 describes the COPYDISK utility program that is used for formatting and copying floppy diskettes.

Section 4 describes the CPMINIT program used to initialize the CP/M Plus directory area on a Model 4 hard disk.

Section 5 describes the BACKREST program used to backup and restore the contents of a hard disk to and from floppy diskettes.

Section 6 describes the ASSIGN utility used to reassign the CP/M Plus logical drive specifiers to the physical drives available in your system.

Section 7 describes the programmer interface to CP/M Plus on the TRS-80 Model 4. It contains technical information necessary to customize programs for the TRS-80 Model 4 environment. This section is for application programmers working in the CP/M Plus TRS-80 Model 4 environment. You should have working experience with CP/M Plus and be familiar with the material in the first four sections of this manual.

Table of Contents

1	CP/M Plus Overview	
1.1	General Characteristics	1
1.2	Video Display Characteristics	1
1.3	Keyboard Characteristics	2
1.4	Printer Characteristics	2
1.5	Floppy Disk Subsystem Characteristics	2
1.6	Hard Disk Characteristics	3
1.7	Device Assignments.	4
1.8	Serial Port Characteristics	5
1.9	Getting Started Without a Hard Disk	5
1.10	Getting Started With a Hard Disk	5
1.11	Getting Started	5
2	System Configuration Utility	
2.1	SETUP General Characteristics	8
2.2	Display Options	9
2.3	Disk Subsystem Options	10
2.4	Parallel Printer Options	11
2.5	Keyboard Options	12
2.6	Serial Port Options	13
2.7	Auto Boot Execution Options	14
2.8	Line Frequency Options	15

Table of Contents (cont.)

3	Diskette Format and Copy Utility	
3.1	COPYDISK General Characteristics	16
3.2	Format Options	17
3.3	Disk Copy Options	18
4	Hard Disk Initialization Utility	
4.1	CPMINIT General Characteristics	19
5	Hard Disk Backup and Restore Utility	
5.1	BACKREST General Characteristics	20
5.2	Backup Options	21
5.3	Restore Options	23
6	Logical to Physical Disk Re-Assignment Utility	
6.1	ASSIGN General Characteristics	25
6.2	Assignment Options	26
7	Console Subsystem	
7.1	Video Display	28
7.2	Keyboard Input	29
7.3	DEC VT-52 Display Emulation	29

APPENDIXES

Appendix A - Keyboard Mapping Table	32
Appendix B - ASCII Character Generation Set	34
Appendix C - The Z80.LIB file	38
Appendix D - Additional Information	39

Section 1

TRS-80 Model 4

CP/M Plus Overview

1.1 General Characteristics

This customized CP/M Plus brings the wealth of programs available under CP/M to the users of the TRS-80 Model 4 and supports the various TRS-80 Model 4 configuration options such as floppy disks, serial port and printers. This implementation of CP/M Plus does not support the Model 4 cassette interface.

In general, CP/M Plus contains all the facilities of CP/M and then some. Further, CP/M Plus maintains file compatibility with all previous versions of CP/M. The file structure allows as many as sixteen drives with up to thirty two megabytes on each drive. Utility programs such as ED, PIP and SUBMIT operate in the same manner under CP/M Plus as they do under previous versions of CP/M. The CP/M 2.2 STAT command has been replaced in CP/M Plus by the SHOW and SET commands.

The memory banked version of CP/M Plus requires the 128K RAM option for the Model 4. The unbanked version requires only 64K RAM in the Model 4. The transient program area (TPA) is where your application programs are executed and the banked version of CP/M Plus provides more memory in this area for the applications. version of CP/M Plus. FOR THIS REASON IT IS SUGGESTED THAT YOU ACQUIRE THE 128K RAM OPTION FOR THE MODEL 4.

1.2 Video Display Characteristics

The TRS-80, Model 4 Video Display Unit has a memory mapped 24 line by 80 character display screen with a variety of special features. Since there is no standard Interface for memory mapped video terminals, a serial TTY interface has been emulated by the BIOS console routines, with software controllable escape sequences allowing selection of the special features. The supported features are compatible with the DEC®model VT-52 CRT Terminal features.

The system configuration utility SETUP, described in Section 2, allows you to select features such as auto line wrap, auto carriage return and cursor format. If none of the special screen features are exercised, then the application program receives a basic serial TTY interface. The standard TTY interface is any printable ASCII character plus Bell, Backspace, Tab, Line Feed, and Carriage Return. If an error occurs during console emulation then an error message will be displayed indicating the failure.

Error messages are cleared by either correcting the indicated condition, such as a disk not ready, or acknowledgment of the message with the ENTER key or CTRL C.

1.3 Keyboard Characteristics

The keyboard configured for the Model 4 is supported as the primary CP/M Plus console input device. User definable Program Function Keys, as well as ESCAPE, CAPS LOCK and CTRL keys are supported by the BIOS console routines. A 64 byte type-ahead buffer is supported. These keyboard options are selectable by using the SETUP utility, described in Section 2.

The complete ASCII character set can be generated from the Model 4 keyboard. The hexadecimal mapping of the ASCII characters to the keyboard is shown in Appendix A.

1.4 Printer Characteristics

Radio Shack Line Printers, connected via a parallel interface, are supported by the customized BIOS. Other printers can be connected if they follow the Centronics parallel interface or the RS-232 serial interface and one of the handshaking protocols, supported by the BIOS serial support routines, described in Section 2.6.

Support for the printers is limited to the basic BIOS calls, configuration management and error recovery. Application programs must provide support for the various printer special features as well as aborts and recoveries. CP/M Plus errors are, however, reported to the user.

Selection of printer options is handled by the SETUP utility, described in Section 2.

1.5 Floppy Disk Subsystem Characteristics

The customized BIOS supports the attachment of four (4) floppy disk drives. The floppy disk format is: 512 byte sectors, 8 sectors per track, 40 tracks, 3 tracks are reserved for the system and 64 directory entries.

Error reporting and error retry options are available to you and are selectable with the SETUP utility. These options are listed below.

- o CP/M Plus always reports fatal error messages to you.
- o You can optionally select recoverable error message diagnostics for display

CP/M Plus detects "not ready" conditions and displays the appropriate error message. Disk error recovery is accomplished by retrying the operation ten (10) times. If the operation fails on all ten retries and you have disabled the "Standard Disk Error Retry" option, the error is treated as non-recoverable and a fatal error message is issued. The error is then returned to BDOS. If you have enabled the "Standard Disk Error Retry" option, you will be asked if more repetitions of the ten retries are desired.

Recoverable errors are always reported to you according to the reporting options you selected through SETUP during system configuration. Fatal errors are always reported to you and to BDOS.

1.6 Hard Disk Characteristics

The system supports up to four (4) Radio Shack disks. The hard disks are initialized by using the CPMINIT utility described in Section 4. Both TRSDOS initialized hard disks and CP/M Plus initialized hard disks can be connected to the system. A single physical hard disk must be either a TRSDOS initialized disk or a CP/M initialized disk. TRSDOS hard disks are not recognized by CP/M Plus.

CP/M Plus uses the same hard disk format as TRSDOS. If it is necessary to format a Radio Shack hard disk the TRSDOS utility INIT should be used. Once formatted, CPMINIT initializes the system tracks and/or the CP/M Plus directory.

The same error reporting and error retry options that are available for floppy disks are available to you for the hard disks and are selectable with the SETUP utility.

When you need to backup your CP/M Plus hard disk, which you should do regularly, use the backup and restore utility discussed in Section 5. This utility enables you to backup data files on the hard disk to floppy diskettes and to restore files that have been previously backed up, to the hard disk. This utility only works for CP/M Plus initialized hard disks.

1.7 Device Assignments

The following correspondence is made between the CP/M Plus logical devices, TRS-80 physical devices and internal operating system names for the TRS-80 physical devices. This correspondence is shown in Table 1-2 below.

Table 1-2. Device Correspondence

CP/M Plus Logical Device	TRS-80 Physical Device	Names for Physical Device
CONIN:	Display Console Keyboard	CRT
CONOUT:	Display Console Video	CRT
AUXIN:	Serial Port	SIOA
AUXOUT:	Serial Port	SIOA
LST:	Centronics Parallel Port	CEN

The assignment of the internal physical device names (CRT, SIOA, etc.) to CP/M Plus logical devices (CONIN, CONOUT, etc.) can be whatever you want them to be. They are currently set as shown in Table 1-2 above.

These physical device names also have attributes associated with them. The attributes are: I=Input, O=Output, S=Serial and X=Xon-Xoff. If a device is given the serial attribute (S) it can also be given a Baud Rate value. Table 1-3 below shows the attributes and values currently assigned.

Table 1-3. Device Attributes/Values

Physical Device Name	Attribute	Value
CRT	IO	None
SIOA	IOS	9600
CEN	O	None

To see the current assignments in effect and to change assignments use the CP/M Plus DEVICE command as described on page 43 of the CP/M Plus (CP/M Version 3) Operating System User's Guide.

For this CP/M Plus implementation the BIOS uses only the device assignments and attributes established by DEVICE. THE BAUD RATE VALUES AND PROTOCOLS THAT THE BIOS USES ARE THOSE DEFINED BY THE SETUP UTILITY.

1.8 Serial Port Characteristics

The RS-232 serial port of the Model 4 is supported as a character stream I/O physical device by CP/M Plus. You can assign this serial port to to any of the CP/M Plus logical devices with the DEVICE command as discussed in Section 1.7 above.

The SETUP utility is used to set the port characteristics and communications protocol (if any). Both ETX/ACK or XON/XOFF software handshaking protocols are supported as well as CTS/RTS hardware handshaking.

1.9 Getting Started without a Hard Disk

The CP/M Plus operating system is contained in a file CPM.SYS that is loaded into memory by the CP/M Plus Loader. The CP/M Plus Loader resides on the system tracks of the CP/M Plus system floppy diskette. When you turn on your Model 4 and insert the system diskette into the "A" or "#0" drive, the Model 4 boot ROM loads the CP/M Plus Loader into memory. This CP/M Plus Loader then loads the remainder of the operating system into memory. System configuration information, as defined by the SETUP utility, also resides on the system tracks and is loaded into memory by CP/M Plus. The CP/M Plus Loader dynamically configures to the available memory size.

When you turn the power on, insert the CP/M Plus system diskette into the #0 drive and close the door or latch. You will hear a buzzing sound and in about 5 seconds the CP/M Plus sign-on message appears. When the A> prompt appears, CP/M Plus is now awaiting your command.

A DIR command displays the contents of the system diskette.

If you've just loaded CP/M Plus for the first time, then immediately make a backup copy of all the distribution diskettes. To make a copy of the distribution diskettes, use the COPYDISK command and execute the "Copy All Tracks" option. The COPYDISK utility is discussed in Section 3. Use the backup copies as your working system diskettes and store the distribution diskettes for safe keeping.

1.10 Getting Started with a Hard Disk Attached

If your Model 4 has a hard disk attached, you must decide if the hard disk is going to be used for CP/M Plus files or TRSDOS files.

If you have a full system configuration, that is 4 floppies and 4 hard disks, then the floppies are numbered 0 through 3 and the hard disks are numbered 4 through 7. If you have only one hard disk it can be either used for CP/M Plus files or TRSDOS

files but not both. If you have more than one hard disk some can be dedicated to CP/M Plus files and some can be dedicated to TRSDOS files.

If you have only one hard disk on your system that you have been using for TRSDOS and you decide to change it to a CP/M Plus disk, be SURE to back up your TRSDOS files to floppy diskettes. Initializing the hard disk with CPMINIT will destroy any files that you may have on that disk.

Section 2

System Configuration Utility

2.1 SETUP General Characteristics

The SETUP program allows you to tailor the operating environment. You can change the system configuration permanently or until the next cold start (power on). With the latter option, you can test a configuration before it is permanent.

You interact with SETUP through the SETUP menus. Each menu has a self explanatory option list. For all SETUP menus, line 24 is 'ENTER OPTION ==>'. Line 23 displays SETUP messages, both informational and error.

The menu system is composed of three levels. The Main Option List allows you to pick which part of the system configuration to examine and/or change. When you have selected one of the system level options the screen will clear and the option menu for the selected subsystem is displayed. At any time you may return to the Main Menu by entering the "E". When you select one of the options from the subsystem menu the specific alternative settings along with the appropriate responses that are available to you are displayed in the lower portion of the menu.

You can exit from SETUP through the Exit Option List.

MAIN OPTION LIST:

- 1 - Display Options
- 2 - Disk Subsystem Options
- 3 - Printer Options
- 4 - Keyboard Options
- 5 - Serial Port Options
- 6 - Auto Boot Execution Options
- 7 - Line Frequency Option

EXIT OPTION LIST:

- P - EXIT and Permanently Update Configuration
- T - EXIT and Test Updated Configuration
- Q - ABORT SETUP with no Configuration Changes

ENTER OPTION ==>

Figure 2-1. Main Menu

Main menu options 1 through 7 cause SETUP to display additional menus which display current values and allow alteration of the configuration. The configuration values displayed are for the system that is currently running.

You must always return to the Main Menu to exit from SETUP. The P option, exits and permanently updates the configuration. The P option also changes the configuration of the running system and records this information on disk. The revised values are incorporated in the running system's memory.

The T option exits and allows testing of the updated configuration. The T option changes only the running system (in memory). These values remain in effect until you run SETUP again or until a cold boot. When you are satisfied with the values, the P option makes the configuration permanent.

The Q option aborts SETUP and does not change the running system or permanent disk configuration.

The SETUP utility also saves the current CP/M Plus I/O redirection vectors when the configuration is made permanent on disk. Although no menu exists for changing the redirection vectors, they can be interrogated, altered and saved using the CP/M Plus DEVICE command.

The second level menus are specific to each functional area of the system configuration: Display, Disk Subsystem, Keyboard, Serial Port, Auto Boot Execution and Line Frequency. Each menu has a full screen display and is self-prompting. When an option is selected and you decide no changes are necessary, ENTER returns you to the menu.

2.2 Display Options

The display option menu allows you to specify characteristics of the video display.

STATUS	DISPLAY OPTIONS:
ENABLED	1 - Auto Line Wrap
DISABLED	2 - Clear Screen on Form Feed
BLINKING	3 - Blinking/Steady Cursor
BLOCK	4 - Block/Underscore Cursor
	E - EXIT TO MAIN MENU
	ENTER OPTION ==>

Figure 2-2. Display Option Menu

When you enable the function "Auto Line Wrap, the input characters are displayed on the next line if the line overflows. When a line ends, a carriage return and a line feed occur automatically. When you disable "Auto Line Wrap", a line overflow results in subsequent characters being displayed in the last character position. Previous overflow characters are overwritten. In either mode, you cannot lose information.

If you enable the function "Clear Screen on Form-Feed", the display screen clears when a form-feed (hex 0C) is sent to the video display (CRT).

Options 3 and 4 allow you to select the format of the cursor.

2.3 Disk Subsystem Options

The disk subsystem menu allows you to specify attributes of the disk subsystem.

STATUS	DISK SUBSYSTEM OPTIONS:
2	1 - Number of Floppy Disk Drives
INACTIVE	2 - Floppy Step Rates
0	3 - Number of Hard Disk Drives
ENABLED	4 - Diagnostic Error Messages
ENABLED	5 - Standard Disk Error Retry
	E - EXIT TO MAIN MENU
	ENTER OPTION ==>

Figure 2-3. Disk Subsystem Menu

You can specify the number of floppy disks on your system (1 to 4) with option 1 of the Disk Subsystem Menu. After specifying the number of floppy disk drives you may specify the step rates for each drive with option 2. The step rate options are: 3 ms, 6 ms, 10 ms or 15 ms.

When you enable option 3, the system reports diagnostic error messages to you when an error, hard or soft, occurs in the disk subsystem. Regardless of the setting of option 3, you always receive reports of non-recoverable errors.

Disk error recovery is always attempted by retrying the operation ten (10) times. If the operation fails on all ten retries and you have disabled Option 4, "Standard Disk Error Retry", the error is treated as non-recoverable and a fatal error message is issued. The error is then returned to BDOS. If, on the other hand, the "Standard Disk Error Retry" option is enabled, you are asked if more repetitions of the ten retries are desired.

2.4 Parallel Printer Options

The Parallel Printer Option menu allows you to specify the attributes of parallel printers. These options are useful if you are using parallel printers other than Radio Shack's.

STATUS	PARALLEL PRINTER OPTION LIST
DISABLED	1 - Suppress Extra Line Feed
DISABLED	2 - Emulate Form Feed
DISABLED	3 - Auto Form Feed
66	4 - Lines per Page
60	5 - Lines before Form Feed
	E - EXIT TO MAIN MENU
	ENTER OPTION ==>

Figure 2-4. Printer Option Menu

Radio Shack printers are usually set up to automatically perform a line feed after a carriage return. Option 1 (when enabled) allows you to suppress a line feed following a carriage return. Enabling Option 2 results in the emulation of a form feed. Using the Option 4 and Option 5 input values, the software keeps track of the current position of the paper in the printer and when a form feed is received, the necessary number of line feeds is sent to advance the paper to the next "top of page". Option 3 when enabled automatically inserts a form feed after the number of lines specified in Option 4 have been sent to the printer.

2.5 Keyboard Options

The keyboard option menu allows you to specify certain characteristics of the Model 4 keyboard support.

STATUS	KEYBOARD OPTIONS:
ENABLED	1 - Type-Ahead Buffer
DEFAULT	2 - F1 Key Codes
DEFAULT	3 - F2 Key Codes
DEFAULT	4 - F3 Key Codes
	E - EXIT TO MAIN MENU
	ENTER OPTION ==>

Figure 2-5. Keyboard Option Menu

Option 1 allows you to enable or disable the 64 byte type-ahead buffer capability in the BIOS. Options 2, 3 and 4 allow you to define the character code or code string, up to 21 characters, returned by the BIOS when programmable function keys F1, F2 and F3 are pressed.

The "DEFAULT" code will be the code returned by pressing F1, F2 and F3 as the Model 4 comes from Radio Shack. If you have input any codes, the status will report "USER". When you select options 2, 3 or 4 when a "USER" status is present, the actual codes are displayed on the lower portion of the menu and you are prompted for changes. These codes can be input in hexadecimal or decimal. If hexadecimal is used it must be preceded by a dollar sign.

NOTE: Type ahead does not function during disk I/O operations. Keys pressed during these times will not be "captured" in the buffer.

2.6 Serial Port Options

The Serial Port menu allows you to specify the attributes of the serial port.

STATUS	SERIAL PORT OPTIONS:
9600	1 - Baud rate
NONE	2 - Line Protocol
NONE	3 - Parity
8	4 - Data Length in Bits
1	5 - Number of Stop Bits
	E - EXIT TO MAIN MENU
	ENTER OPTION ==>

Figure 2-6. Serial Port Option Menu

Selection of Option 1 allows you to set the Baud rate for the port. There are 17 Baud rate values available from 0 to 19,200. Option 2 allows you to select ETX/ACK, XON/XOFF or no protocol for the software handshaking protocol or you may select the hardware handshaking protocol CTS/RTS. Option 3 allows you to select either odd or even parity or no parity at all. Option 4 allows you to select either 5, 6, 7 or 8 bits as the data length. The number of stop bits can be set with Option 5 to 1, 1.5 or 2.

----- WARNING -----

The CP/M Plus DEVICE utility has an option to set the serial port baud rate. In CP/M Plus on the Model 4 this option of DEVICE is disabled. The only way you may change the serial baud rate is by using the SETUP utility option described above.

2.7 Auto Boot Execution Options

The Auto Boot Execution option menu allows you to enable the file WARM.SUB to be automatically executed on warm boot.

```

STATUS                                AUTO BOOT OPTIONS:

DISABLED                             1 - Warm Start Exec WARM.SUB File
                                     E - EXIT TO MAIN MENU

ENTER OPTION ==>
```

Figure 2-7. Auto Boot Execution Menu

Enabling Option 1 specifies that a predefined file WARM.SUB is to be automatically executed on a warm start (CONTROL C or program termination). You must, of course, specify the contents of WARM.SUB by using either a full screen editor (word processor) or the CP/M Plus context editor, ED.

When using the "Auto Boot Execution" option caution must be exercised when enabling and using WARM.SUB. Since most application programs are exited by a warm start a system diskette which has WARM.SUB enabled may never let the operator out of the application defined in the file WARM.SUB. On the other hand this may be very desirable if certain operators need to be confined to a specific application program or set of procedures.

2.8 Line Frequency Options

If you are in an area where the AC power is 50 rather than 60 Herz, the Line Frequency option menu allows you to change the operating system for 50 Herz operation.

STATUS	LINE FREQUENCY OPTIONS:
60 Hz	1 - Power Line Frequency
	E - EXIT TO MAIN MENU
	ENTER OPTION ==>

Figure 2-8. Line Frequency Menu

Option 1 allows you to specify the AC power frequency environment in which the operating system will be operated. The only options are 50 and 60 Herz.

Section 3

Diskette Format and Copy Utility

3.1 COPYDISK General Characteristics

The COPYDISK program allows you to format and copy floppy diskettes. You interact with COPYDISK through the COPYDISK menus. Each menu has a self-prompting option list. For all COPYDISK menus, line 24 is 'ENTER OPTION ==>'. Line 23 displays both COPYDISK informational and error messages.

The menu system consists of two levels. The main menu allows you to select a format operation or a copy operation. A copy operation always formats the destination diskette prior to the copy operation when you select the "COPY ALL" option.

COPYDISK is an image copy program in that it copies an image of the source diskette onto the destination diskette.

MAIN OPTION LIST:

- 1 - Format and Erase a Diskette
- 2 - Copy the Contents of One Diskette to Another
- E - EXIT TO CP/M

ENTER OPTION ==>

Figure 3-1. Main Menu

Main Menu Options 1 and 2 cause COPYDISK to present menus that display Format and Copy options. Use the E option from the main menu to exit from COPYDISK.

3.2 Format Options

The format option menu allows you to specify a format option and to format a diskette using the selected option.

STATUS	FORMAT OPTION LIST:
1	1- Location of Diskette to be Formatted
	FORMAT COMMAND LIST:
	S - START FORMAT OPERATION
	E - EXIT TO MAIN MENU
	ENTER OPTION ==>

Figure 3-2. Format Option Menu

Option 1 selects either A, B, C or D as the drive to be formatted. S starts the format operation. Remember, a format operation erases all files that may be on the destination diskette. The Format Menu E option returns you to the Main Options Menu.

3.3 Disk Copy Options

The Copy Options menu allows you to specify parameters for copying one diskette to another.

STATUS	COPY OPTION LIST:
A	1 - Location of SOURCE Diskette
B	2 - Location of DESTINATION Diskette
ALL	3 - Copy All, System or Data Tracks

COPY COMMAND LIST:

S - START COPY OPERATION

E - EXIT TO MAIN MENU

ENTER OPTION ==>

Figure 3-3. Copy Options Menu

Options 1 and 2 specify the source and destination drives.

Option 3 allows you to select one of two copy modes: copy all tracks or copy only the system tracks. When you select the copy "ALL" option it is not necessary for the diskette to have been previously formatted. The copy "ALL" first formats the destination diskette, erasing all files that may be on the diskette. After completion of the format, the program reads tracks from the source diskette, and then writes them to the destination diskette. This process continues until the entire source diskette is read and copied.

The "SYSTEM TRACKS" alternative of option 3 allows only the system tracks of the source diskette to be copied to the destination diskette. In this case, the destination diskette is not formatted.

Section 4

Hard Disk Initialization Utility

4.1 CPMINIT General Characteristics

The hard disk initialization utility CPMINIT allows you to initialize a formatted Radio Shack hard disk for CP/M Plus use. CPMINIT initializes the CP/M Plus directory.

STATUS	CPMINIT OPTION LIST
DISK 4	1 - Destination Physical Drive
INACTIVE	2 - Initialize CP/M Directory
	E - EXIT TO CP/M-PLUS
Enter Option ==>	

Figure 4-1. Main Menu

Option 1 selects the physical hard disk drive to be initialized (4 - 7) (Logical E thru H). Selection of Option 3 causes the following message to be displayed on the lower portion of the menu: All Files Will Be Erased On Hard Disk 4 -- OK To Continue? (Y or N). Typing "Y" results in the execution of the format operation. The hard disk can now be used for storing CP/M Plus files. It is not necessary to initialize the hard disk with the "System Tracks" option in order to use the disk for CP/M Plus, initializing the CP/M Plus Directory with Option 3 is all that is necessary.

The Radio Shack hard disks are formatted and initialized for TRSDOS when the disk is added to the Model 4 by the Radio Shack dealer. Since CP/M Plus uses the same hard disk format as TRSDOS, the TRSDOS utility INIT should be used to reformat if it ever becomes necessary.

Section 5

Hard Disk Backup and Restore Utility

5.1 BACKREST General Description

The BACKREST utility allows you to easily and safely backup the files stored on your CP/M Plus hard disk(s) onto floppy diskettes and to just as easily restore the files to your CP/M Plus hard disk(s) should some system malfunction corrupt your file integrity. The utility allows a file that is larger than a single diskette's storage capacity to span more than one diskette. In order for you to have a sufficient number of floppy diskettes ready to support a backup operation executing the "Estimate" option of the Backup function gives you the number of floppy diskettes required. You also have the option to direct the BACKUP function to make use of or ignore the CP/M Plus ARCHIVE attribute associated with files on the hard disk.

The menu system is composed of three levels. The Main Menu allows you to pick either a backup or a restore operation. The BACKUP and the RESTORE menus which are displayed when Option 1 or 2 is selected from the Main Menu are self-prompting. For each of the BACKREST option menus, 'Enter Option ==>' and the prompting cursor is displayed on line 24. Both informational and error messages are displayed on line 23.

When you select one of the options from either the BACKUP or the RESTORE Option Menus the selection alternatives that are available to you are displayed in the lower portion of the menu. At any time you may return to the Main Menu by using the "E" option.

Main Option List:

- 1 - Backup Hard Disk
- 2 - Restore Hard Disk
- E - EXIT TO CP/M-PLUS

Enter Option ==>

Figure 5-1. Main Menu

Main Menu options 1 and 2 cause BACKREST to present menus that display BACKUP and RESTORE options. The E option from the Main Menu exits from TRSCPM to CP/M Plus.

5.2 Backup Options

The BACKUP Options Menu allows you to specify the parameters of a backup operation. Prior to executing a backup operation, you can use the Estimate option to find out how much total storage is required for a particular Backup operation. This will give you an indication of how many floppy diskettes will be required for the backup.

STATUS	BACKUP OPTION LIST
E	1 - Source Disk Drive
O	2 - Source User Area
A	3 - Destination Floppy Drive
,	4 - Files To Backup
ENABLED	5 - Recognize ARCHIVE Attribute
BACKUP	6 - Backup or Estimate Operation
	S - START OPERATION
	E - EXIT TO MAIN MENU
	ENTER OPTION ===>

Figure 5-2. Backup Option Menu

Option 1 allows you to specify the hard disk drive to be backed up. Legitimate drive designations depend on the logical to physical drive relationship established by the ASSIGN utility. If you have not changed the default logical to physical drive relationship with ASSIGN, the legitimate hard disk drive names are E, F, G or H.

Option 2 allows you to specify the user area (0 - 15) of the source disk that you want to backup. Option 3 allows you to select the destination floppy disk drive. As above, if you have not changed the default logical to physical drive relationships with ASSIGN, the legitimate floppy disk drive names are A, B, C or D.

BACKREST will only allow a backup operation from hard disks to floppy disks. Thus if you specify a source drive name that is assigned to floppy drives or a destination drive name that is assigned to a hard disk drive BACKREST will not allow the operation.

Option 4 allows you to specify specific files to be backed up, using the CP/M Plus ambiguous or unambiguous file specification convention. In addition specifying a file of type ".BUB" causes the list of files predefined in the specified ".BUB" file to be backed up and/or restored.

Option 5 allows you to select whether the CP/M Plus "ARCHIVE" file attribute is recognized by BACKUP (only specified files not previously backed up will be backed up in this operation) or ignored (all specified files are backed up).

With Option 6 you may select either a Backup operation or an Estimate operation. The Estimate operation calculates the total diskette storage required by the currently specified Backup operation. Option 7 initiates the Backup or Estimate operation.

You return to the Main Menu with the "E" option. During the Backup operation, you are prompted to change destination diskettes at the appropriate time.

5.3 Restore Options

The RESTORE Options Menu allows you to specify the parameters of a hard disk restore operation.

STATUS	RESTORE OPTION LIST
A	1 - Source Floppy Drive
E	2 - Destination Disk Drive
O	3 - Destination User Area
SOURCE	4 - List File Directory
.	5 - Files to Restore
RESTORE	6 - Restore or Estimate Operation
INACTIVE	S - START OPERATION
	E - Exit To Main Menu

ENTER OPTION ==>

Figure 5-3. Restore Option Menu

Option 1 allows you to specify the hard disk drive to be restored. Legitimate drive designations depend on the logical to physical drive relationship established by the ASSIGN utility. If you have not changed the default logical to physical drive relationship with ASSIGN, the legitimate hard disk drive names are E, F, G or H.

Option 2 allows you to specify the user area (0 - 15) of the destination disk that you want to restore. Option 3 allows you to select the source floppy disk drive. As above, if you have not changed the default logical to physical drive relationships with ASSIGN, the legitimate floppy disk drive names are A, B, C or D.

Option 4 allows you to obtain a directory listing to the CRT screen of either the source or destination disk.

Option 5 allows the User to specify the files to be restored, using the CP/M Plus ambiguous or unambiguous file specification convention.

Option 6 allows you to select the next initiated operation to be either a Restore operation or an Estimate operation. The Estimate operation calculates the total storage requirements (in normal expanded file format) that the Restore operation will require. Option 7 initiates the Restore or Estimate operation.

You return to the Main Menu with the "E" option. During the Restore operation, you are prompted to change destination diskettes at the appropriate time.

Section 6

Logical Disk Reassignment Utility

6.1 ASSIGN General Description

The ASSIGN utility allows you to reassign the logical disk drive designations of the floppy and hard disk subsystems.

For example, the first physical hard disk drive (#4) is normally given the logical designator "E". Should you use the ASSIGN utility to reassign physical drive #4 to be "A", any further references, by you or application programs, to drive 'A' will access physical hard disk drive #4. This feature is of most use when you are running application programs that use absolute "hard coded" drive designations to reference program and data files.

ASSIGN allows you to specify a new logical drive designation for any of the active physical drives attached to your system.

OPTION LIST:

- C - CHANGE Logical-to-Physical Drive Assignments
- P - EXIT and Permanently Update Drive Assignments
- Q - ABORT ASSIGN with no Drive Assignment Changes

ENTER OPTION ==>

Figure 6-1. ASSIGN Main Menu

When you select Option C the screen and a new full screen menu is presented. This menu allows you to review the current logical to physical drive assignments and to change them if you desire.

After making any changes, selecting the P Option causes the new assignments to be written to the system diskette. When the writing is complete the CRT screen clears and the following message appears: Drive Assignment Options Have Been Saved On Disk. System Must Be Rebooted For New Assignments To Take Effect. This message is followed by the A> and you are back to CP/M Plus. Reset the Model 4 and after the boot is complete the new assignments are in effect.

You may exit from ASSIGN without changes by selecting the Q Option.

6.2 Assignment Options

This display shows the current logical to physical disk drive assignments in effect and allows you to edit these assignments.

DRIVE ASSIGNMENTS AS CURRENTLY DEFINED:

Number of Floppy Disk Drives: 4
Number of Hard Disk Drives: 4

A: 0F	B: 1F	C: 2F	D: 3F	E: 4H	F: 5H	G: 6H	H: 7H
I:	J:	K:	L:	M:	N:	O:	P:

ENTER PHYSICAL DRIVE NUMBER TO ASSIGN TO LOGICAL DRIVE:

(0 - 3 for Floppy Drives, 4 - 7 for Hard Disks)
("S" to skip (no assignment), "E" to end entry)

A:	B:	C:	D:	E:	F:	G:	H:
I:	J:	K:	L:	M:	N:	O:	P:

Are assignments correct?

Y - EXIT with changes, N - Reassign drives,
Q - EXIT with no changes

ENTER OPTION ==>

Figure 6-2. Disk Reassignment Menu

The top portion of the Disk Reassignment Menu shows the number of active drives in the system (as set when you run SETUP) and the logical to physical drive assignments. The TRS-80 Model II physical disk drives are designated as 0, 1, 2 and 3 for floppy drives and 4, 5, 6 and 7 for hard disks. For example if you have a single floppy drive and a single hard disk the TRS-80 designation would be: floppy drive #0 and hard disk #4. CP/M Plus, on the other hand, uses alpha characters for logical drive names.

For this implementation of CP/M Plus the default logical to physical drive assignments are those shown in the top half of the Disk Reassignment Menu above. Until you make changes in these default assignments, floppy drive #0 will always be designated A and hard disk #4 will always be designated D. Additional floppies will always be designated B through C and additional hard disks will always be designated E through H in alphabetical order.

However if you choose to use ASSIGN to change these assignments, there are no restrictions on the assignments that you may make. For example a very common set of assignments for a system with two floppy drives and one hard disk is for the hard disk to be designated C and the two floppies designated A and B.

You must be very careful when reassigning logical to physical drive designations. If you forget what assignments you used it is very easy to lose files during a copy or format operation if you use the wrong drive names.

Section 7

Console Subsystem

7.1 Video Display

A 2,048 byte video display buffer makes up the memory mapped console display on the TRS-80 Model 4. Each character contains 7 bits that define the character and 1 bit that indicates reverse video.

CP/M Plus for the TRS-80 Model 4 supports the display screen as a 24 line by 80 character emulation of the DEC model VT-52 CRT Terminal. The VT-52 functions emulated are detailed in Section 7.3. If the character being written to the screen is not involved in screen control, then the system places the character in the screen storage at the current cursor position and the cursor position increases by 1. If the cursor is at the end of the line and the line wrap option is in effect, then the cursor is positioned to column 1 of the next line. If the line wrap option is not in effect, then the cursor remains at the end of the line and the last character is overlayed until a carriage return operation is performed.

If an attempt is made to perform a line-feed when the cursor is positioned on line 24, then the display screen scrolls upward 1 line. The scroll is accomplished by moving lines 2 through 24 to lines 1 through 23, blanking line 24 and positioning the cursor at line 24 column 1. The current cursor position and screen mode are maintained in the BIOS data area.

While in graphics mode, all characters with the Hex 80 bit on are displayed in the Model 4 graphics character set. To use the reverse video mode, graphics mode must be turned off. Then all characters with the Hex 80 bit on are displayed in reverse video.

All characters sent to the screen are exclusive or'd with the current attribute. If reverse video attribute is enabled, the current attribute is Hex 80. If reverse video attribute is disabled, the current attribute is Hex 00. Therefore, characters sent to the screen while under the reverse video attribute are displayed in the inverse of their normal sense (e.g. a Hex 20 will display as a reverse blank and a Hex A0 will display as a normal blank).

The setting of graphics mode does not affect the attribute. Therefore, with both graphics mode on and reverse video attribute set, the characters from Hex 00 to Hex 7F will be displayed in their graphic representations. Note that the reverse video attribute affects characters going to the screen, while graphics mode affects characters on the screen.

NOTE: The VT/52 emulator supplied is only a subset of the VT/52 capabilities.

7.2 Keyboard Input

All input from the keyboard is stacked in a FIFO input buffer by the console status routine after analysis. There are two reasons for the input buffer. First, the input buffer allows data to be read from the keyboard and analyzed before ready status is returned to the user so that the user is given a true indication of input ready. Also, the input buffer allows a convenient way to stack multi-character key input for the caller such as the cursor movement keys. The character input routine simply fetches the next character from the input buffer. analysis.

The keyboard is a switch array. Since there is no interrupt capability for the keyboard, it is implemented with a polling methodology. The polling is performed by the timer interrupt handler.

Appendix A shows the Hexadecimal codes that are issued by the keyboard when using CP/M Plus and Appendix B shows the appropriate keystrokes to generate the ASCII character set.

7.3 DEC VT-52 Display Emulation

The emulation of the DEC VT-52 display terminal allows an application program, through the use of an established set of escape sequences, to control the display screen independent of the actual memory mapped screen implementation. On entry to the character output routines, the following special sequences are checked and emulated according to the VT-52 specification.

Decimal Code	Hex Code	Escape Sequence	Function
27,42	1B,48	ESC H	Home Cursor, moves the cursor to line 1, character column 1
27,64	1B,43	ESC C	Cursor Right
27,68	1B,44	ESC D	Cursor Left
27,66	1B,42	ESC B	Cursor Down
27,65	1B,41	ESC A	Cursor Up
27,43	1B,49	ESC I	Reverse Index
27,106	1B,6A	ESC j	Save Cursor Position

CP/M Plus for the TRS-80 Model 4

Decimal Code	Hex Code	Escape Sequence	Function
27,104	1B,6B	ESC k	Restore Cursor Position
27,110	1B,6E	ESC n	Read Cursor Position
27,69	1B,45	ESC E	Clear Screen, clears the display and homes the cursor
27,100	1B,64	ESC d	Erase Beginning of Display to Cursor
27,44	1B,4A	ESC J	Erase from Cursor to End of Page
27,46	1B,4C	ESC L	Erase Entire Line
27,111	1B,6F	ESC o	Erase Beginning of Line to Cursor
27,45	1B,4B	ESC K	Erase from Cursor to End of Line
27,108	1B,6C	ESC l	Insert Blank Line
27,44	1B,4D	ESC M	Delete Line
27,48	1B,4E	ESC N	Delete Character
27,101	1B,65	ESC e	Enable Cursor
27,102	1B,66	ESC f	Disable Cursor
27,112	1B,40	ESC p	Enter Reverse Video Mode
27,113	1B,41	ESC q	Exit Reverse Video Mode
27,118	1B,46	ESC v	Wrap at End of Line
27,119	1B,44	ESC w	Discard at End of Line
27,58	1B,3A	ESC :	Program Function Keys
27,90	1B,5A	ESC Z	Respond to VT-52 Interrogation
4	07	CTRL G	Bell causes the video display to flash briefly

Decimal Code	Hex Code	Escape Sequence	Function
8	08	CTRL H	Backspace blanks the current cursor position and moves the cursor to the left one column. If the cursor is at the left end of the line, it will not move.
10	0A	CTRL J	Line Feed moves the cursor down one line. If the cursor is on line 27 the cursor remains there and all of the data on the screen is scrolled up one line. Data on the top line is scrolled off of the screen.
13	0D	CTRL M	Carriage Return moves the cursor to the first position of the current line.
9	09	CTRL I	Horizontal Tab moves the cursor 8 positions to the right.

Direct cursor positioning is accomplished by the following escape sequence:

ESC Y Row+20H Col+20H where Row = 1-24, Col = 1- 80

A selectable cursor format (blinking or nonblinking and underscore or block) is provided. These characteristics can only be set through the SETUP utility.

Appendix A

Hexadecimal Keyboard Mapping

The following table shows the hexadecimal codes that are generated by the Model 4 keyboard when running CP/M Plus.

LEGEND	UNSHIFT	SHIFT LEFT	SHIFT RIGHT	CAPS LOCK	CONTROL
! 1	31	21	21	31	7C
" 2	32	22	22	32	1C
# 3	33	23	23	33	1D
% 5	35	25	25	35	1F
& 6	36	26	26	36	7E
' 7	37	27	27	37	60
(8	38	28	28	38	5B
) 9	39	29	29	39	5D
0	30	..	..	30	1B
* :	3A	2A	2A	3A	..
= -	2D	3D	3D	2D	5F
BREAK	81	..	..	81	..
F1	F1	F1	F1	F1	..
F2	F2	F2	F2	F2	..
F3	F3	F3	F3	F3	..
UP ARROW	0B	85	85	0B	5E
Q q	71	51	51	51	11
W w	77	57	57	57	17
E e	65	45	45	45	05
R r	72	52	52	52	12
T t	74	54	54	54	14
Y y	79	59	59	59	19
U u	75	55	55	55	15
I i	69	49	49	49	09
O o	6F	4F	4F	4F	0F
P p	70	50	50	50	10
	40	7B	7D	40	00
LEFT ARROW	08	83	83	08	..
RIGHT ARROW	09	82	82	09	..
7	37	37	37	37	37
8	38	38	38	38	38
9	39	39	39	39	39
DOWN ARROW	0A	84	84	0A	0A
A a	61	41	41	61	01
S s	73	53	53	73	13
D d	64	44	44	64	04
F f	66	46	46	66	06
G g	67	47	47	67	~

CP/M Plus for the TRS-80 Model 4

LEGEND	UNSHIFT	SHIFT LEFT	SHIFT RIGHT	CAPS LOCK	CONTROL
H h	68	48	48	68	08
J j	6A	4A	4A	6A	0A
K k	6B	4B	4B	6B	0B
L l	6C	4C	4C	6C	0C
+ ;	3B	2B	2B	3B	7F
ENTER	0D	0D	0D	0D	0D
CLEAR	8A	80	80	8A	80
4	34	34	34	34	34
5	35	35	35	35	35
6	36	36	36	36	36
LEFT SHIFT	N/A	N/A	N/A	N/A	N/A
Z z	7A	5A	5A	7A	1A
X x	78	58	58	78	18
C c	63	43	43	63	03
V v	76	56	56	76	16
B b	62	42	42	62	02
N n	6E	4E	4E	6E	0E
M m	6D	4D	4D	6D	0D
< ,	2C	3C	3C	2C	..
> .	2E	3E	3E	2E	..
? /	2F	3F	3F	2F	5C
RIGHT SHIFT	N/A	N/A	N/A	N/A	N/A
1	31	31	31	31	31
2	32	32	32	32	32
3	33	33	33	33	33
CTRL	N/A	N/A	N/A	N/A	N/A
Space Bar	20	20	20	20	20
CPS	N/A	N/A	N/A	N/A	N/A
0	30	30	30	30	30
.	2E	2E	2E	2E	2E
ENTER	N/A	N/A	N/A	N/A	N/A

Appendix B

ASCII Character Set

The following table shows the hexadecimal representations of the numeric codes for ASCII characters. The keystroke(s) necessary to generate the ASCII characters are also shown.

HEXADECIMAL CODE	CHARACTER	GENERATED BY ...
00	NUL	CTRL
01	SOH	CTRL A
02	STX	CTRL B
03	ETX	CTRL C
04	EOT	CTRL D
05	ENQ	CTRL E
06	ACK	CTRL F
07	BEL	CTRL G
08	BS	CTRL H or LEFT ARROW
09	TAB	CTRL I or RIGHT ARROW
0A	LF	CTRL J or DOWN ARROW
0B	VT	CTRL K or UP ARROW
0C	FF	CTRL L
0D	CR	CTRL M or ENTER
0E	SO	CTRL N
0F	SI	CTRL O
10	DLE	CTRL P
11	DC1	CTRL Q
12	DC2	CTRL R
13	DC3	CTRL S
14	DC4	CTRL T
15	NAK	CTRL U
16	SYN	CTRL V
17	ETB	CTRL W
18	CAN	CTRL X
19	EM	CTRL Y
1A	SUB	CTRL Z
1B	ESC	CTRL 0
1C	FS	CTRL 2
1D	GS	CTRL 3
1E	RS	CTRL 4
1F	US	CTRL 5
20	SPACE	SPACE BAR
21	!	! (exclamation)
22	"	" (quote)
23	#	# (pound)
25	%	% (percent)
26	&	& (ampersand)
27	'	' (apostrophe)

HEXADECIMAL CODE	CHARACTER	GENERATED BY ...
28	(	( (left paren)
29	)	) (right paren)
2A	*	* (asterisk)
2B	+	+ (plus)
2C	,	, (comma)
2D	-	- (minus)
2E	.	. (period)
2F	/	/ (slash)
30	0	0
31	1	1
32	2	2
33	3	3
34	4	4
35	5	5
36	6	6
37	7	7
38	8	8
39	9	9
3A	:	: (colon)
3B	;	; (semi-colon)
3C	<	< (less than)
3D	=	= (equals)
3E	>	> (greater than)
3F	?	? (question)
40		@ (at)
41	A	A
42	B	B
43	C	C
44	D	D
45	E	E
46	F	F
47	G	G
48	H	H
49	I	I
4A	J	J
4B	K	K
4C	L	L
4D	M	M
4E	N	N
4F	O	O
50	P	P
51	Q	Q
52	R	R
53	S	S
54	T	T
55	U	U
56	V	V
57	W	W
58	X	X
59	Y	Y

CP/M Plus for the TRS-80 Model 4

HEXADECIMAL CODE	CHARACTER	GENERATED BY ...
5A	Z	Z
5B	[	CTRL ((left bracket)
5C	\	CTRL / (back slash)
5D	]	CTRL) (right bracket)
5E	^	CTRL UP ARROW (carrot)
5F	_	CTRL = (underscore)
60	`	CTRL ' (accent grave)
61	a	a
62	b	b
63	c	c
64	d	d
65	e	e
66	f	f
67	g	g
68	h	h
69	i	i
6A	j	j
6B	k	k
6C	l	l
6D	m	m
6E	n	n
6F	o	o
70	p	p
71	q	q
72	r	r
73	s	s
74	t	t
75	u	u
76	v	v
77	w	w
78	x	x
79	y	y
7A	z	z
7B	{	LEFT SHIFT (left brace)
7C	|	CTRL ! (logical or)
7D	}	RIGHT SHIFT (right brace)
7E	~	CTRL & (tilde)
7F	DEL	CTRL +
80	(see note below)	SHIFT CLEAR
81	HOME CURSOR (ESC H)	BREAK
82	CURSOR RIGHT (ESC C)	SHIFT RIGHT CURSOR
83	CURSOR LEFT (ESC D)	SHIFT LEFT CURSOR
84	CURSOR DOWN (ESC B)	SHIFT DOWN CURSOR
85	CURSOR UP (ESC A)	SHIFT UP CURSOR
86		Unused
87		Unused
88		Unused
89		Unused
8A	CLEAR SCREEN (ESC E)	CLEAR

NOTE: Hex 80 inverts the reverse video/graphics option. For example if you are in graphics mode a hex 80 invokes reverse video and if you are in reverse video a hex 80 invokes graphics.

Appendix C

The Z80.LIB File

The CP/M Plus assemblers, MAC™ and RMAC™ include instruction mnemonics for Intel®8080 and 8085 microprocessors. Since they are macro assemblers macros may be defined to represent mnemonics and corresponding machine code for other microprocessors. CP/M Plus includes a file which contains macro definitions for the Z80®microprocessor which is in the Model 4. The name of the file is Z80.LIB and to use it to define the Z80 instructions to MAC or RMAC you must insert the following line in your assembly language program:

```
MACLIB Z80
```

On encountering this pseudo-op in the source program the assembler will open the file Z80.LIB and read the definitions and machine code for all of the Z80 mnemonics. The assembler will then recognize and be able to decode Z80 instructions which appear in the source file.

The MACLIB pseudo-op must appear before any Z80 instructions in the source file.

The library file may be on any drive but if it is not on the default drive the drive specifier must be included in the instruction. For example, if you plan to have the Z80.LIB file on drive B: and to have drive A: as the default then the pseudo-op in the program should read file must be as follows:

```
MACLIB B:Z80
```

To see a list of the macros enter:

```
type Z80.lib <enter>.
```

Appendix D

Additional Information

1. When the DIR command is used without options, the files will be listed in unsorted order. When the DIR command is used with options or is preceded by a drive specifier, the files will be listed in sorted order (unless NOSORT is used).
2. If the COPYSYS program returns a "possible incompatible disk format" error, check to see if the disk is write-protected and make sure it is inserted in the drive properly.
3. SETUP and DEVICE retain their own table of parameters. As a result, they will not always show the same parameter values for the same device or characteristics.
4. PIP will not recognize the end-of-file specifier EOF: if entered on the command line with the PIP command. To use the EOF: specifier, run PIP in the multiple command mode as described in the CP/M Plus User's Guide.
5. The banked implementation of CP/M Plus on the Model 4 has approximately 55K bytes of transient program area (LTPA) in which to run applications programs. The unbanked version has approximately 44K bytes of TPA.